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PROPER DISPOSAL OF EXPIRED AND UNUSED DRUGS - A GLOBAL OVERVIEW

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ABSTRACT

A proper drug disposal is required for unused drugs that remain after the end of the medical treatment and expired drugs in hospital, wholesale and retail pharmacy, industry and homes because improper drug disposal leads off environmental contamination, risks to human health, medication fish down toilets or thrown in the trash that can contaminate the water source, affecting the aquatic life and accidental ingestion by children or pets. In India, knowledge and awareness about current Good Drug disposal practices are lacking among the general public. These practices need to be improved in order to protect the environment. This paper reviews the guidelines for proper drug disposal methods given by World Health Organization, expired drug collection methods from people and importance of drug disposal. This paper further explains the effects of improper drug disposal, some flaws of drug disposal in our country, laws of drug disposal and their future aspects for the regulation of drug disposal.

KEYWORDS: Drug disposal, environmental contamination, WHO guidelines, disposal practices.

INTRODUCTION

Drugs are indispensable part of the medical care system a proper drug disposal is required for unused drugs that remain after the end of the medical treatment and expired drugs in hospital, wholesale and retail pharmacy, industry and homes it is important for good drug management system. A questionnaire based survey was conducted in india, it results as lack of the safe drug disposal awareness in majority peoples. Most medicine consumers lack awareness about the proper disposal of expired and unused medicines it resulting as rinsing the medicine down to the sink or flushing them in the toilet or discarding the medicines in the garbage thus disturb the ecosystem. So, need to minimizing expenses for disposal of pharmaceutical waste involves sorting different products and following their specific disposal methods accordingly, thereby optimize resource allocation and environmental impact.

METHODS OF DRUG DISPOSAL

World health organization guideline for methods of safe disposal of expired and unused drugs. Those methods are classified in two types.

► Methods of drug disposal in home

1. Return to donor

The process of returning unusable drugs for safe disposal by the manufacturer Should be considered, especially for medications like antineoplastics that pose disposal challenges. Additionally, unwanted donations, particularly those nearing or past their expired, could potentially be returned to the donor for proper disposal.

2) Sewer

Properly diluted liquid pharmaceutics or antiseptics can be safely disposed of in sewer or fast-flowing water source, but caution is necessary in situation where sewers are damaged, required the expertise of a hydrogeologist or sanitary engineer to mitigate potential risk to public health and the environment.

3) Discus with local guidelines

Always consult local authorities for specific disposal instruction in your area to ensure proper handling and disposal of bulk or liquid pharmaceuticals, as regulation may vary depending on your location.

► Methods of drug disposal in industries

1) Landfill

The landfill method involves directly depositing waste into designated land disposal sites without any pre-treatment or preparations, making it the oldest and most commonly used approach for solid waste disposal, there are two types of landfill.

A) Non engineering dump
Dumping untreated waste into unregulated open areas harms the local environment and should be avoided. They should preferably be discharged after immobilization or inertization.

B) Engineering landfill
A well-designed landfill should be located away from water source and situated above the water table. Daily waste should be compacted and covered with soil to ensure hygienic condition. The term "safe sanitary landfill" describes a site that is properly located, built, and maintained to minimize environmental risks.

2) Waste immobilization (encapsulation)
Encapsulation involves solidifying pharmaceutical within a plastic or steel drum. The drum is filled with 75% solid and semi-solid pharmaceuticals, and the remaining space is filled with materials like cement or plastic foam. The bend back of lids of the drums are cut open for filling the lime, and then sealed after reaching capacity. Once the drums are filled to 75% capacity, the mixture of lime, cement and water in the proportions 15:15:15 (by weight) is added and drum filled to capacity. These sealed drums are placed at bottom of a municipal waste, sometimes placed on pallets for transportation.

Encapsulation of antineoplastic drugs required the safe disposal system for the two-chamber incinerator, which are used in chemotherapy treatments. The secondary chamber, or after-burner, is indeed crucial for ensuring that any aerosolized cytotoxi waste from the primary chamber is completely incinerated. These prevent the release of any harmful substance into the environment. The high temperature of at least 1200ºC in the secondary chamber is key to achieving this level of destruction.

3) Waste immobilization (inertization)
Inertization, a process akin to Encapsulation, entails the removal of pharmaceutical packing materials such as paper, cardboard, and plastics, with pills extracted from blister packs. The pharmaceuticals are subsequently ground and mixed with water, cement, and lime to create a homogeneous paste. Workers must wear the productive clothing and masks due to potential dust hazards. The past is then transported in liquid form by a concrete mixer truck to a landfill, where it is poured in regular urban waste. The process requires equipment like grinders or road rollers for pharmaceutical crushing, a concrete mixture and steady supply of cement, lime, and water.

The approximate ratios by weight used are as follows
- Pharmaceutical waste - 65%
- Lime -15%
- Cement - 15%

Water - 5% or more to form a proper liquid consistency.

4) Burning in open containers
Pharmaceuticals should avoid low-temperature burning in open containers to prevent the release of toxic pollutants into air. While paper, cardboard packing can be burnt if not recycled, polyvinyl chloride plastics must not be incinerated due to environment concerns.

5) Medium temperature incineration
In emergency scenarios, authorities may deem it necessary to disposal of expired solid pharmaceuticals using a two-chamber incinerator operating at 850ºC, with a combustion retention time of at least two seconds in the second chamber. It's advised to diluted the pharmaceutical waste with significant amounts of municipal waste at a ratio of approximately 1:1000.

6) High temperature incineration
Industries utilizing high-temperature technologies like cements kilns, coal fired thermal power stations, or foundries typically operate furnaces at temperatures well above 850ºC, with extended combustion retention times and exhaust gases dispersed through tall chimneys, often reaching high altitudes.

During cement raw material burning, temperature can reach 1450ºC, with combustion gases reaching up to 2000ºC, and gas residence times at these temperature lasting several seconds. These condition effectively disintegrate all organic waste compounds. Incinerators meeting this regulation are suitable for disposing of halogenated compound, x-ray contrast media, and povidone iodine, while lower- temperature incinerators should be avoided.

7) Chemical decomposition
If you can't burn waste using a proper incinerator, you might consider breaking it down chemically as suggested by the manufacturer, and then burying it. This approach is only advisable if you have access to chemical expertise because it's complex lengthy process. You also need to have a constant supply of the necessary chemicals. While this method could work for disposing of small amounts of cancer-treating drugs, it's not suitable for large amounts, like over 50 kilograms, because you'd have to apply this chemicals many times even for small batches.
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Table 1: Different disposal methods their applications as recommended by WHO.

S.NO	Disposal methods	Types of pharmaceuticals	Demerits
1	**Return to donor.**	All bulk waste pharmaceuticals, particularly antineoplastics.	Not practical, time consuming.
2	**Sewer or fast flowing water source.**	Small quantities of well diluted liquids, syrups, intravenous fluids and disinfectants.	Not applicable for undiluted antineoplastics and disinfectants.
3	**Landfill. (Highly engineered sanitary landfill)**	Limited quantities of untreated solid, semi-solid and powders. Preferable after immobilization, PVC plastics.	Only suitable for isolated place in water source and a place where people live.
a)	**Engineered landfill.**		
b)	**Non-engineered landfill.**	Preferable for after immobilization of solid, semi-solid, pvs plastics.	Not suitable for untreated substance.
4	**Waste immobilization. (encapsulation)**	Solid, semi-solid, powders, liquids, antineoplastics, controlled substance.	Can be used by industries and municipality.
5	**Waste immobilization. (inertization)**	Solid, semi-solid, powders, liquids, antineoplastics, controlled substance.	Can be used by industries and municipality.
6	**urning in open containers.**	Drug backing materials, paper, card board.	Not suitable for pvc plastics.
7	**Medium temperature incineration. (850ºC)**	Solid, semi-solid, powders, controlled substance.	Not suitable for antineoplastics.
8	**High temperature incineration. (1200ºC-2000ºC)**	Solid, semi-solid, powders, controlled substance and antineoplastics.	Expensive.
9	**Chemical decomposition.**	Not recommended unless special.	Not practical quantities over 50kg.

Table 2: Effect of improper disposal of drugs.

S.NO	IMPROPER DOSPOSAL	EFFECTS
1	The practice of flushing drugs into the water source.	Reduce the water quality and increasemortility in aquatic spices and affect its appearance, behavior, and reproduction.
2	Throwing the drugs in public and private waste bins.	The risk of accidental or intentional misuse and poisoning is a critical public health concern.
3	Burning in not built up-up environment.	Toxic pollutants may be released into open environment.
4	Disposal of antibiotics in open environment.	Leads to mutation and the development of anti microbial resistance in bacteria.
5	Directly throwing the drugs in open land.	Plants are affected due to soil erosion which also turn affect the humans due to bioaccumulation**.**

- Flushing the anti-depressant, adrenoreceptor blockers in water source reduce the fish fertility and estrogenic chemicals that made male fathead minnows more feminine in appearance and fish that tend to hide shadows were to sunlight after exposure to drug concentration.[2]
- Mitotone, ketoconazole, cardiacglycoside, nitrofurane, carbamazepine and astazene these drugs bioaccumulated food long time consumption causes of endocrine disorders in humans.[3]
- Bombay natural history society said that loss of over 99% of all the population of vultures between the 1990-2006 this is the reason is consuming of diclofenac bioaccumlated foods.[21]

Table 3: Awareness on drug disposal.

S. NO	Region	Year	Research instrument	Numbers of participants	Type of participates	Observation
1	south India[4]	2013	Direct interview; questionnaires	158	Patients	Majority (65%) of them were not aware of risk and dispose medicines by throwing into the dustbin/trash (63.5%).
2	North India[5]	2014	questionnaires containing both open and close end questions	84	Pharmacists	Around 90% of participant had some kind of medications stored at home and disposing via dustbin.
3	South India[6]	2015	Face to face interview	127	Pharmacists	63.9% of the participant were not aware of environmental hazards and disposal of unwanted medicines by throwing in trash (35%).
4	India [7] (Tamilnadu)	2015-2016	Cross – section survey.	1000	Common peoples	78.6% of peoples throw the trash, 6.1% of peoples burning in open air and 3.3% of peoples flushing in to toilets and sink.
5	India [8] (Tamilnadu)	2017	Cross-sectional questionnaire based study.	156	Medical professionals	77.7% throwing their household dustbins ,2.6% flushing in toilet and 19.2% return to pharmacy.
6	North India[9]	2018	Cross-sectional observational questionnaire based study.	220	Medicine consumers	95% of participates followed by common method in throw in garbage.
7	India [10] (New Delhi)	2019	Face to face interview	956	Medicine consumers	92.6% of the consumers threw away the expired medicines in trash.
8	India [11] (Tamilnadu)	2020	A community based crass-sectional study.	400	Each number of family.	Majority of participate disposal in unused drugs in trash (53.1%). A populations (71.2%) are unwire of disposal practice like drug take back systems.
9	Eastern India[12] (Odisha)	2020-2021	Questionnaire based study	385	General public.	82.1% of population threw unused drugs in dustbins, only 2.6% return to pharmacy.
10	India[13] (North Karnataka)	2021	Questionnaire based study	306	Common peoples	51 % participates throwing the unused medicine in household garbage, 2% flushing in toiler or sink and 6% return to pharmacy.
11	India[14]	2022	A descriptive crass-sectional study.	402	Pharmacy students	55.5% of populations throw the unused and expired drug away in household
12	India[15]	2023	A descriptive crass-sectional study.	212	Householders	Major practice for drug disposal was reported as throwing in household garbage (93.1%)

- Apart from that, V. Pugazhvendhan enthusiast complained 25 times on illegal bio medical waste in the last four years in Chennai and surrounding areas. He said that there are just nine operators in Tamilnadu for drug disposal.[17]

- This study is focus on the improper disposal of drugs in garbage, toilet, sink and sewer and on the possible threats to the environment which violet human health. In addition to seeking straightforward drug disposal method and establishing a suitable management system, the study aims to educate the public about the harmful biological consequence resulting from the improper disposal of drugs.

GOOD DRUG DISPOSAL PRACTICES

Some many countries conduct the take back programs and handling the some methods for collecting the expired and unused drug in common peoples for safe disposal of expired and unused drugs. They can be found below.

1. United states

The Drug enforcement administration creates the national initiative. There are two kind of options in U.S.[18]

1.1 Permanent collection sites

The authorized collection sites may be retail pharmacy, hospitals, or clinic pharmacies; or law enforcement facilities collect the unused and expired medicine in common peoples. These collection sites offer the drug-take boxes and home disposal methods.

Figure 1: US drug take box.

1.2 Periodic take back events.

The drug take back conduct the annually twice in April and October. The drug take back events are part of a mission to create safe medication disposal sites, prevent the transfer of the prescribed drug for illicit use and create the awareness in publics. Lest April 2021, the program reported the collection of 420 short tons of drugs in 5,060 sites.

2. Tennessee

Unwanted Household Pharmaceuticals collected through the Take back Program, their office has placed 355 collection bins throughout Tennessee - 282 at police stations, 10 at universities, and 100 at pharmacies. Last 2021 April take back day, safely and securely disposed of 27,230 puonds medications.[19]

Figure 2: Tennessee drug take box.

3. Northern California.

Butte-Glenn Medical Society is a physician-led membership organization located in Northern California, affiliated with the California Medical Association. They place drug take back boxes at different locations. In addition to the safe disposal sites, there are annual drug take back days each spring and fall.[20]

Figure 3: California drug take box.

CONCLUSION

- Drug take-back boxes provide a place where unused and expired drugs can be safely disposed. To eradicate environmental hazards caused by improper disposal of drugs, these permanent boxes must be placed in every retail pharmacy.
- Medication collection events and programs are part of a nationwide effort to reduce the amount of pharmaceutical products being flushed or poured down drains.
- In addition, facilities and infrastructure to treat and disposal waste and collection units should be increased in order to properly demolish different kinds of formulation according to WHO guidelines.

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